

Using Nitrogen-Reducing Biofilter Systems to Control Nitrogen Loads from Onsite Sewage Treatment and Disposal Systems (OSTDS)

Background and Goals of the Proposed Project

With the support of the USEPA's multipurpose grant, we plan to achieve two goals for demonstrating the nitrogen treatment effectiveness of two-stage nitrogen reducing onsite sewage treatment and disposal systems:

- (1) Extend the monitoring and water quality sampling of four existing nitrogen-reducing systems by two extra sampling events to evaluate the effect of system maintenance activities.
- (2) Monitor two new in-ground nitrogen-reducing biofilters (INRB) to evaluate their nitrogen-reducing and possible factors influencing their effectiveness. A secondary goal is to evaluate the sampling approach and suitability of several sampling instruments for the unsaturated soil underneath drainfields in preparation for future additional monitoring projects on INRB when more funding becomes available.

Nutrients, such as nitrogen and phosphorus, are essential for food production to support the ever-growing human population and the health of natural plant and animal communities. Too much nutrients entering the natural ecosystems, however, can cause impairments. Based on data from the United States Environmental Protection Agency (USEPA), more than 100,000 miles of rivers and streams, close to 2.5 million acres of lakes, reservoirs and ponds, and more than 800 square miles of bays and estuaries in the United States have poor water quality because of nutrient pollution (USEPA, 2019). Based on the water quality assessment conducted by the Florida Department of Environmental Protection (FDEP, 2018a), 24 of the 30 Outstanding Florida Springs (OFS) were identified as impaired for nitrate. Sources of nitrogen include agricultural and urban fertilizer application, feces from farm animals, land application of treated wastewater from wastewater treatment plants, onsite sewage treatment and disposal systems (OSTDs), and atmospheric deposition. The Florida Department of Health (FDOH, 2017) estimates that over two million OSTDS are currently operating in Florida. The vast majority of these systems are conventional OSTDS comprised of a septic tank followed by disposal of treated wastewater into the environment using a drainfield. This type of system, if installed and maintained properly, can remove most organic materials, suspended particles, phosphorus, and bacteria from the wastewater. But these systems, typically only remove about 25-35% of the nitrogen (FDOH, 2015). In urban areas where many OSTDS are used to treat wastewater, contribution of nitrogen from OSTDS to groundwater can be more than 50% of all the sources (FDEP, 2018b). Controlling nitrogen loads from OSTDS should be an integral part of watershed nutrient management.

To identify cost-effective approaches to control OSTDS nitrogen contribution, in 2008, the Florida Legislature directed the Florida Department of Health (FDOH) to conduct the Florida Onsite Sewage Nitrogen Reduction Strategy (FOSNRS) study (FDOH, 2015). Through a literature review and ranking, two-stage systems were selected as the top-ranking nitrogen-reducing systems to be tested. This type of system employs two stages of treatment. Stage 1 treatment uses porous media with high aeration potential, such as sand, expanded clay, and clinoptilolite, to facilitate nitrification and convert most ammonia in the septic tank effluent into nitrate. Stage 2 uses porous media feeding either heterotrophic (wood or lignocellulose) or autotrophic (sulfur) denitrification processes or combination of both to convert nitrate into nitrogen gas and remove the nitrogen from the wastewater (Hazen and Sawyer, 2009b). Following pilot-scale testing and evaluation of the results, the research team constructed seven

full-scale two-stage biofilter systems for residences across Florida. These systems employed various designs and were constructed between 2011 and 2013 (FDOH, 2015). All systems were monitored at least eight times during a period from 2011 through 2014, generally, on a bi-monthly basis. The purpose of the monitoring was to evaluate the treatment effectiveness and reliability, both for nitrogen and for other pollutants such as biochemical oxygen demand (BOD), total suspended solid (TSS), phosphorus and bacteria, and document the construction and maintenance costs of these systems (Hazen and Sawyer, 2010). Data from monitoring these full-scale two-stage nitrogen-reducing systems demonstrated that they can achieve 65% - 97% of nitrogen removal from household domestic wastewater. Maintenance requirements for these systems were low and mainly related to new construction and installation system adjustments.

At the end of the FOSNRS study, the project team recommended that FDOH establish a long-term monitoring schedule for these systems to evaluate continued system performance, and the longevity of media. Results from the continued monitoring will provide guidance for system design refinements and long-term needs for maintenance and monitoring.

To restore nitrogen-impaired Outstanding Florida Springs, following the 2016 Florida Spring and Aquifer Protection Act (373.801-373.811, Florida Statute – F.S.), FDEP adopted 13 basin management action plans (BMAP) in 2018 to address the spring impairments. The OSTDS remediation plans included in these BMAPs require that new OSTDS construction on lots less than one acre in the priority focus areas (PFA) of nitrogen-impaired OFS incorporate nitrogen-reducing systems. FDEP also initiated a Septic Upgrade Incentive Program in September of 2018 to encourage homeowners in PFAs of non-agricultural spring BMAP basins to upgrade their existing systems to nitrogen-reducing systems.

In parallel and in preparation for implementation of BMAP-requirements, in 2018, FDOH incorporated the “in-ground nitrogen-reducing biofilter” (INRB) into Florida’s onsite sewage regulations (Rule 64E-6.009(7), Florida Administrative Code -F.A.C.) as one of the options to control nitrogen loads from OSTDSs. An INRB is an approach that uses the two-stage treatment underneath a drainfield to remove nitrogen. This is one of the passive nitrogen-reducing biofilter system configuration tested during the FOSNRS study. While monitoring of INRBs similar to the one specified in regulations was conducted by FOSNRS and FDEP previously, more data collection on INRBs installed exactly according to rule specifications is needed. This type of monitoring is critical in evaluating the effectiveness of nitrogen-control as this technology is applied on a larger scale.

In mid-2017, FDOH resumed the monitoring on the four remaining nitrogen-reducing systems constructed during the FOSNRS study. The goal of the monitoring was to evaluate the long-term performance of these systems as they become mature, and identify possible design issues, system refinement solution, maintenance requirements, and system operation and maintenance costs. All four systems have been sampled six times since mid-2017. Funding was available to sample these systems eight times. Recently, decreases in performance have been found and maintenance was conducted on these systems. It is desirable to extend the monitoring beyond what was planned originally to evaluate the effect of these maintenance activities.

With the support of USEPA’s multipurpose grant, we plan to achieve two goals for demonstrating the nitrogen treatment effectiveness of two-stage nitrogen reducing onsite sewage treatment and disposal systems:

- (1) Extend the monitoring and water quality sampling of four existing nitrogen-reducing systems by two extra sampling events to evaluate the effect of system maintenance activities.
- (2) Monitor two new in-ground nitrogen-reducing biofilters (INRB) to evaluate their nitrogen-reducing and possible factors influencing their effectiveness. A secondary goal is to evaluate the sampling approach and suitability of several sampling instruments for the unsaturated soil underneath drainfields in preparation for future additional monitoring projects on INRB when more funding becomes available.

Tasks for the Proposed Project:

The proposed project will include two tasks:

(1) Task One:

This task will extend the monitoring and water quality sampling on the four FOSNRS systems by two extra sampling events to evaluate effects of system maintenance activities. Results from this project will facilitate the implementation of these OSTDS designs in Florida to help reduce nitrogen loads to Florida aquifers and restore OFS and surface waterbodies across the state that are impaired for nutrients.

To accomplish this goal, several objectives are identified for the proposed project:

- Monitor the long-term performance of the systems in reducing nitrogen from the household domestic wastewater, particularly after maintenance activities to identify their effect. Continue monitoring the concentrations of different nitrogen species at designated sampling locations to evaluate the dynamics of nitrogen removal rate as these systems become established and mature. Identify possible environmental or operational factors that may influence the nitrogen removal efficiencies of these systems.
- Continue monitoring the operation and maintenance cost of the systems to verify the derived long-term cost estimated using the life-cycle cost analysis tool developed in the FOSNRS contract.
- Continue monitoring the concentrations of other water quality constituents, including biochemical oxygen demand (BOD₅), total suspended solids (TSS), total phosphorus (TP), orthophosphate (PO₄), and the abundance of indicator bacteria such as fecal coliform and E. coli. Results from the monitoring project will provide more information regarding the overall performance of these nitrogen removal systems in removing these priority pollutants from residential sewage.

To meet these objectives, a combination of field parameter collection and system monitoring is planned on the four nitrogen-reducing biofilter systems, which include one site in Marion County (BHS-7), and three sites in Seminole County (BHS-3, BHS4, and BHS-5). Both counties are in the central Florida area (**Figure 1**). Water quality samples from each site will be collected for the septic tank effluent, effluent after treatment by the two-stage nitrogen treatment system, and any intermediate locations along the treatment train. Sampling points will be kept the same as those

being sampled during the FOSNRS and the current monitoring project so that the newly collected data can be compared with the historic data to derive long-term performance. System monitoring and water quality sample collection on these systems have been conducted six times since mid-2017. Two more sampling events are anticipated to be completed by the end of 2019. The two extra sampling events to be funded by the USEPA Multipurpose Grant will be conducted in the first and second quarters of 2020.

Table 1 shows the web links to a set of FOSNRS monitoring reports describing the system design and sampling points for all five systems included in this project. The data sets generated will enable quantification of hydraulic, organic, and nitrogen loading rates; average influent and effluent concentrations; removal efficiencies for nitrogen and other parameters; and effluent nitrogen concentrations achieved. System performance on removing other pollutants will also be quantified and compared to the historic data for the long-term performance evaluation. Documentation of system status, operation and maintenance procedures and costs, and system performance issues will also be documented throughout the continued monitoring project. The monitoring will initiate as soon as the funding becomes available and will last for two years. Field parameters and water quality samples from these systems will be collected on a quarterly basis. **Table 2** shows the inspection and monitoring activities that will be conducted on all the four systems. **Table 3** shows the water quality constituents sampled for this project. Several field parameters, including water temperature, pH, specific conductivity, dissolved oxygen (DO) concentration and saturation, and oxidation-redox potential (ORP) will also be measured in this project to evaluate the condition and status of these systems.

Table 1. Documents Providing Details on System Structure and Sampling Design

System	Documents Providing Detailed Description on System Structure and Sampling Design
BHS-3	http://www.floridahealth.gov/environmental-health/onsite-sewage/research/b7c1.pdf
BHS-4	http://www.floridahealth.gov/environmental-health/onsite-sewage/research/b7d1.pdf
BHS-5	http://www.floridahealth.gov/environmental-health/onsite-sewage/research/b7e1.pdf
BHS-7	http://www.floridahealth.gov/environmental-health/onsite-sewage/research/b7g1.pdf

Table 2. Tentative Monitoring Schedule Framework

Task	Nominal Frequency	Actions	Product
Site Inspection	Quarterly	Visual inspection, ascertain operability, odors, water levels in tanks, examine drainfield observation ports, for inground nitrogen-reducing system: determine drainfield elevation.	Completed inspection checklist; log entries

Flow/volume and energy consumption	Quarterly	Record water meter and/or flow, electric meter if applicable, make spreadsheet entry	Updated household water use/system flow and energy consumption if applicable.
Maintenance	As needed	Record maintenance activities conducted on the system by project personnel or homeowners.	Maintenance log entries, documented cause of problem, action taken, cost of maintenance
Chemical and microbiological sampling and filed parameter measurements	Quarterly	Monitor chemical and microbiological parameters in influent, effluent and intermediate process points where applicable, and measure field parameters.	Data set of chemical and microbiological parameters, log of removal efficiencies and effluent concentrations for total nitrogen, nitrogen species, and other water quality parameters

Table 3. Parameters Included in This Project, Methods to Be Used, and Method Detection Limits*

Analytes	Method of Analysis	Method Detection Limit
Carbonaceous Biochemical Oxygen Demand (CBOD5)	SM 5210B	2.0 mg/L
Chemical Oxygen Demand (COD)	EPA 410.4	7.2 mg/L
Total Kjeldahl Nitrogen (TKN-N)	EPA 351.2	0.05 mg/L
Ammonia Nitrogen (NH4-N)	EPA 350.1	0.008 mg/L
Nitrate Nitrogen (NO3-N)	EPA 300.0	0.01 mg/L
Nitrite Nitrogen (NO2-N)	EPA 300.0	0.01 mg/L
Nitrate/Nitrite Nitrogen (NOx-N)	EPA 300.0	0.01 mg/L
Total Phosphorus (TP)	EPA 365.3	0.005 mg/L
Orthophosphate as P (Ortho P)	SM 4500 P-E	0.002 mg/L
Sulfate	EPA 300.0	0.27 mg/L
Sulfide	SM 4500S-D	0.0083 mg/L
Hydrogen Sulfide	SM 4500S-D	0.0083 mg/L
Total Suspended Solids (TSS)	SM 2540D	2.0 mg/L
Total Organic Carbon (TOC)	SM 5310B	0.25 mg/L
Total Alkalinity	SM 2320B	5 mg/L CaCO ₃
Fecal Coliform	SM 9222D	1 cfu/100 mL
E. coli	EPA 1603	1 cfu/100 mL

* The methods listed on this table are preferred methods. Different methods may be used depending on selected laboratory if the laboratory can provide justification that the alternative method is generally equivalent to the preferred method or better.



Figure 1. General Locations of the Four Nitrogen-Reducing Biofilter Systems

The project team is currently using Advanced Environmental Laboratories, Inc. for all sample analyses through a purchase order agreement. The current purchase order will last through June of 2020. After that, if necessary, the project team will solicit quotes for laboratory selection. The selection will be based on that a given laboratory is NELAP certified for the desired parameters, their location relative to the systems to be sampled (to meet sample holding times), and the price the laboratory can offer. There is a possibility that different laboratories may be used for sample analysis during the project period. The methods listed on Table 3 represent what are currently used by the laboratory. If methods different from those listed in Table 3 will be used, the laboratory will need to provide justification that the substitute methods are equivalent to those listed in the table or better.

All sample collection, equipment preparation, decontamination, and documentation procedure for this project will conform to the requirements and criteria in the following FDEP standard operating procedures:

[FA 1000, Administrative Procedures](#)
[FC 1000, Decontamination Procedures](#)
[FD 1000, Documentation Procedures](#)
[FQ 1000, Field Quality Control](#)
[FS 1000, General Sampling Procedures](#)
[FS 2000, General Aqueous Sampling](#)
[FS 2100, Surface Water Sampling](#)
[FS 24000, Wastewater Sampling](#)

Field blank, equipment blank, and field duplicates will be collected at frequency of about 10% of the water quality samples.

All field parameter measurements will be conducted using a YSI 556 model multi-parameter system. Pre-sampling and post-sampling calibration will be conducted before and after every system event for every monitored system. Calibration will be conducted based on the YSI 556 user manual procedure.

Results from all field assessment, field parameter measurements, elevation measurements, water meter reading, electricity meter reading will be documented, and together with the results of water quality samples, be entered into a Microsoft Access database. All field and laboratory results will be provided to the funding agency as part of the interim/final deliverable.

The following calculations or data treatments will be used to examine the overall performance of the nitrogen-reducing systems included in this project in removing nitrogen, as well as the other critical pollutants. The hydraulic loading and energy consumption of these systems will also be evaluated.

- Percent nitrification of the Stage 1 medium: This will be examined by calculating and compare the percent TKN concentrations in TN concentrations in both the influent (septic tank effluent) and effluent of the Stage 1 medium. Comparing the percent TKN concentration in TN concentration of both the influent and effluent of the Stage 1 medium will demonstrate the effectiveness of the nitrification of the Stage 1 medium. Alkalinity values

of the influent and effluent will also be compared to interpret whether the change of alkalinity is a limiting factor of the nitrification.

- Percent nitrogen removal by the Stage 1 medium: This will be estimated as the percent difference between the TN concentrations in the influent and effluent of the Stage 1 medium to demonstrate the efficiency at which the nitrogen is removed by the Stage 1 medium.
- Percent nitrogen removal by the lignocellulose medium: This will be estimated as the percent difference between the TN concentrations in the influent (Stage 1 medium effluent) and the effluent of the lignocellulose medium, which demonstrates the efficiency of the lignocellulose medium in removing nitrogen).
- Percent nitrogen removal by the sulfur medium: This will be estimated as the percent difference between the TN concentrations in the influent (lignocellulose medium effluent) and effluent of the sulfur medium, if applicable (systems B-HS3, B-HS4, and B-HS5) to demonstrate the effectiveness of further nitrogen removal by the sulfur medium layer after the wastewater goes through the sulfur medium.
- Percent nitrogen removal by the entire treatment system: This will be estimated as the percent difference between the TN concentrations in the influent (septic tank effluent) and effluent of the whole treatment system. The effluent of the treatment system is represented by either the top water in the sulfur tank (B-HS3), or sulfur chamber of the Stage 2 media tank (B-HS4 and B-HS5), or the water collected from the sampler lysimeters located immediately adjacent to the effluent points of the lignocellulose medium overflow (B-HS7). This estimation demonstrates the overall nitrogen removal efficiency of the entire treatment system.
- Percent removal rate of other pollutants, including CBOD5, TSS, orthophosphate, TP, fecal coliform, and E. coli by Stages 1 and 2 media and the entire treatment system will also be estimated using the same methods described above for estimating the nitrogen removal efficiency by the Stages 1 and 2 media and the whole treatment system.
- The hydraulic loading of the treatment system will be estimated as the difference between the accumulative flow meter readings of two consecutive sampling events.
- The energy consumption of the treatment system (if pump tank exists and electric meter functions properly) will be estimated as the difference between the electric meter readings of two consecutive sampling events.

The following statistical analyses will be conducted to answer several questions:

- Do water quality data fit a normal distribution? This question is important because it determines if statistical analysis based on the assumption of a normal distribution and using the mean and standard deviation as descriptive statistics for this study are valid. We will explore if some data transformation, for example, using the logarithmic value of the raw data will make the data more conform with the normal distribution. The original FOSNRS data sets and the data set collected for this project will be assessed separately for Kurtosis and Skewness to see if the data fit a symmetrical distribution. If not, distribution of the data after several transformations will be examined to identify the transformation closest to the normal distribution. If analysis based on normal distributions are not valid, we will use non-parametric statistics.
- One important goal of this project is to establish the long-term performance of these nitrogen-reducing systems. Therefore, it is important to ask the question whether there are significant differences between the pollutant removal efficiency of these systems during the period of FOSNRS study and this project. To answer this question, the data set for the FOSNRS study and this project will be compared using student t or Kruskal-Wallis-tests to see if statistically significant differences exist.

- The long-term performance of these system will also be examined using regression trend analysis to indicate whether there is any statistically significant trend of the pollutant removal efficiency through time. This analysis will be done by aggregating the data from the FOSNRS study and the data from this project for each system, and conducting the trend analysis.
- Another important question to ask is whether the pollutant removal efficiency is impacted by any environmental factors. To answer this question, scatter plots, and correlation analyses will be conducted between the pollutant removal efficiency and factors such as influent pollutant concentrations, input hydraulic loading, input pollutant loads, availability of organic carbon (CBOD5 and TOC concentrations), change of alkalinity, oxygen concentration, oxidation-redox potential, temperature, and seven-day antecedent rainfall, etc. This kind of analysis may provide suggestions on how to manage and improve the overall system performance.
- For the in-ground nitrogen-reducing system (B-HS7), are samples from different locations representing the same treatment step different or similar enough that they could be composited to increase sample volume? Based on previous experience gained by the DOH project team sampling these systems, it was not possible to collect sufficient quantity of sample for even the most important pollutants (e.g. ammonia, nitrate/nitrite, TKN). To answer this question, the spatial variability of the pollutant concentrations will be examined by aggregating the water quality data collected from each sampling point collected during the FOSNRS study and this project, and conducting ANOVA or non-parametric tests to see if statistically significant difference existing among sampling points. This will provide suggestions on future sampling design for the in-ground system.
- Scatter plots and correlation between different analytes for each system will also be conducted to examine relationships between analytes, and see if these are strong enough to allow estimation of one from the other. For example, is there any relationship between the CBOD5 and TOC concentrations? Is the oxidation of CBOD5 related to nitrification? Is nitrogen removal related to phosphorus removal? To answer these questions, data from the FOSNRS study and from this project will be tested for consistency and then either together or separately analyzed.

(2) Task Two

The main goal of this task is to evaluate the nitrogen-reducing effectiveness and reliability of two INRB-installations and assess if they achieve the minimum 65% nitrogen-reducing efficiency required by the spring BMAPs. A secondary goal is to evaluate the sampling approach and suitability of several sampling instruments for the unsaturated soil underneath drainfields in preparation for future additional monitoring projects on INRB when more funding becomes available. The project will also examine possible factors that may impact the nitrogen-removal effectiveness, such as hydraulic and nitrogen loads, water residence time, alkalinity limitation, availability of reactive media material, and drainfield configuration (subsurface system vs. mound system, trench vs. bed). Results from this project will provide a better understanding on how INRBs function in Florida.

The two INRB will be located in Leon and Wakulla County that are part of the priority focus area (PFA) of the nitrogen-impaired Wakulla Spring. **Figure 2** shows the general area for the proposed task. To achieve the goal of this task, the following objectives will be achieved:

- Establish the selection criteria for potential INRB locations to be included in this project.
- Identify the candidate INRB locations, encourage homeowners of the candidate INRB systems to enroll in the project.

- Install monitoring equipment into the selected INRB.
- Inspect and conduct sampling on the selected system quarterly for six quarters.
- Conduct drainfield elevation measurements and field parameter measurements.
- Document system construction costs and maintenance efforts and costs.
- Conduct data analyses to evaluate nitrogen-reducing efficiencies, reliability, and influencing factors.

The selection process will aim to recruit single family residences that are year-round occupied. The selection will occur in coordination with installers and system owners to facilitate the installation of sampling equipment during construction of the INRB, and the gathering of construction costs. The following information will also be collected: soil type and texture, estimated seasonal high-water table, type of drainfield (subsurface drainfield vs. fill and mound drainfields), wastewater distribution method (gravity vs. pressure dosing), texture and composition of nitrification and denitrification layers.

The general structure of an INRB is shown in **Figure 3**. The system uses two layers of porous material to remove nitrogen from domestic wastewater. The dominant form of nitrogen in the raw sewage discharged into a septic tank is organic nitrogen. Most organic nitrogen is converted into ammonia in the septic tank so that the dominant nitrogen species in the septic tank effluent is ammonia. The effluent from the septic tank is discharged to the drainfield. A nitrification sandy layer of at least 18 inches thickness is constructed immediately underneath the absorption surface (bottom) of the drainfield. This layer is made of either sand or fine sand and facilitates oxidation of ammonia in the septic tank effluent to nitrate. The nitrified wastewater then infiltrates through at least 12 inches of the lignocellulosic (woody) layer underneath the sandy layer. This denitrification lignocellulosic layer contains organic carbon and facilitates denitrification to remove nitrogen from the wastewater. Fine aggregates, such as fine sand, very fine sand, coarse sandy loam, sandy loam, loamy sand, etc. are required to be mixed with the lignocellulosic materials to facilitate infiltration of nitrified wastewater into the lignocellulosic layers and help increase the residence time of nitrified water in the lignocellulosic.

Septic tank effluent samples will either be collected directly using a peristaltic pump from the septic tank or from a pump tank located immediately downstream of the septic tank. Pore water samples from bottom of both media layers will be collected using suction lysimeters or pan lysimeters. The current plan for the monitoring design assumes that lysimeters will be installed in three rows: at the proximal end, in the middle, and at the distal end of the drainfield and at the bottoms of the nitrifying and denitrifying layers, respectively. **Figure 4** shows a plain view of locations of lysimeters to be installed underneath the drainfield. **Figure 5** shows the cross-section view of the locations of lysimeters to be installed in the drainfield.

To evaluate the nitrogen-removal effectiveness, this project will monitor concentrations of nitrogen species, including total Kjeldahl nitrogen, ammonia, and nitrate/nitrite, by collecting and analyzing samples from septic tank effluent, the bottom of the nitrification sandy layer, and bottom of the denitrification lignocellulosic media layer.

In addition to nitrogen species, water samples will also be collected for analyzing total phosphorus (TP). These data will help evaluate the phosphorus removal capability of the INRB system. In addition, total organic carbon concentration will be measured to examine whether the lignocellulosic layer adds a measurable amount of organic carbon to the final effluent of the INRB to evaluate the possible impact of lignocellulosic materials on the DO consuming organic carbon loads to the groundwater. Alkalinity will be a secondary parameter to be monitored in

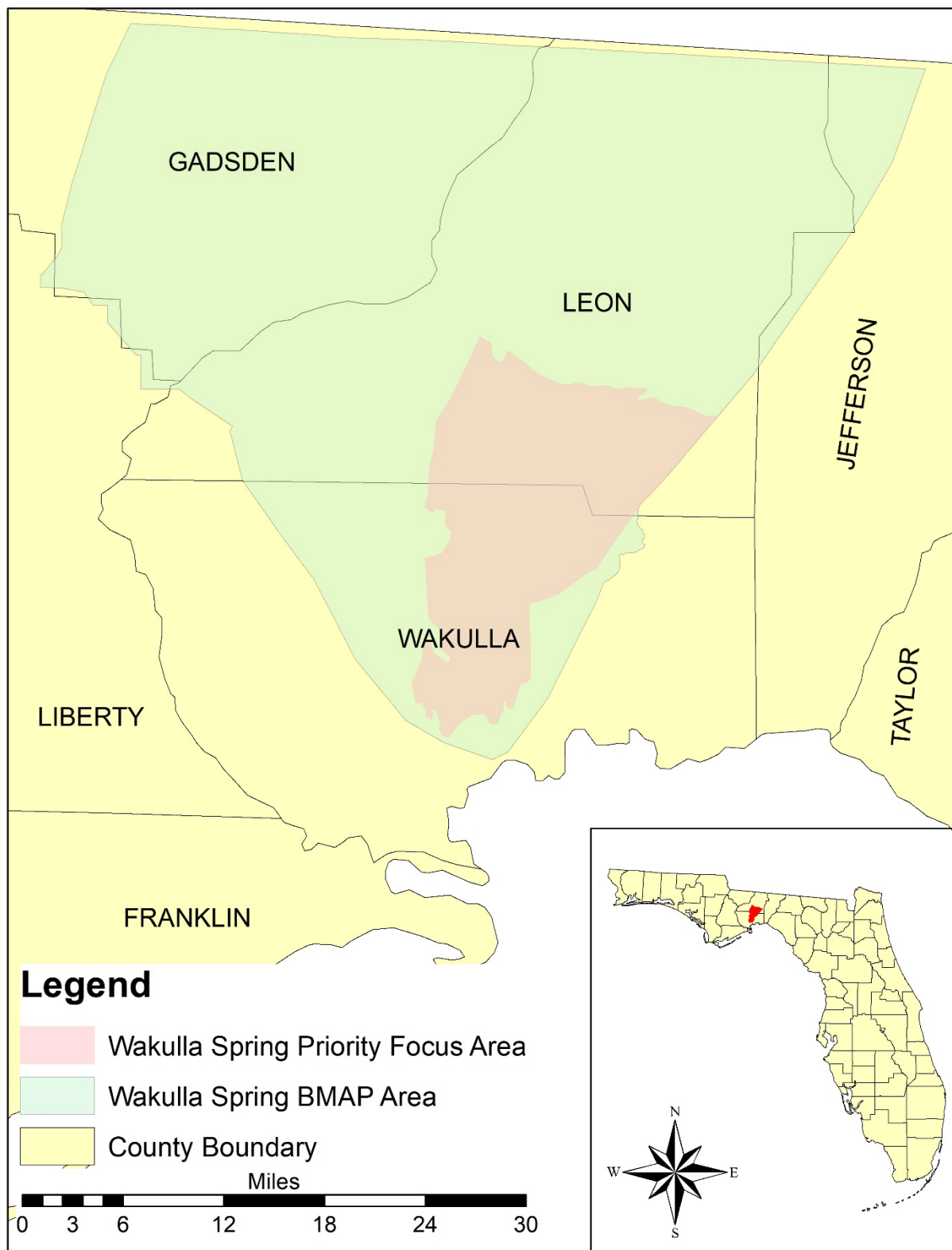


Figure 2. Location of the Priority Focus Area of the Nitrogen-Impaired Wakulla Spring Basin

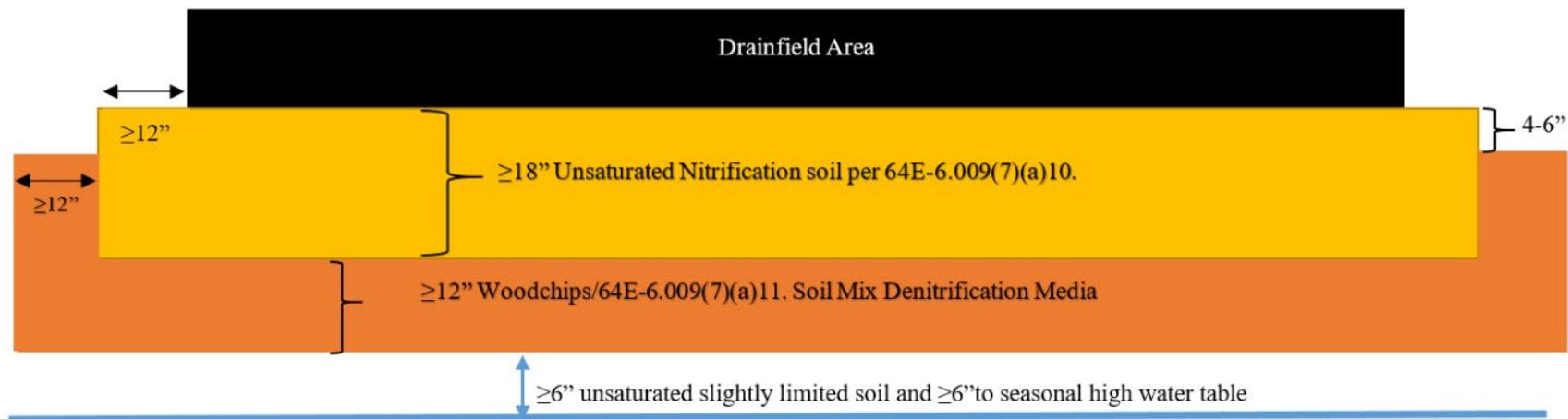


Figure 3. The General Structure of an In-ground Nitrogen-Reducing Biofilter (INRB) (64E-5.009(7) of the Florida Administrative Code)

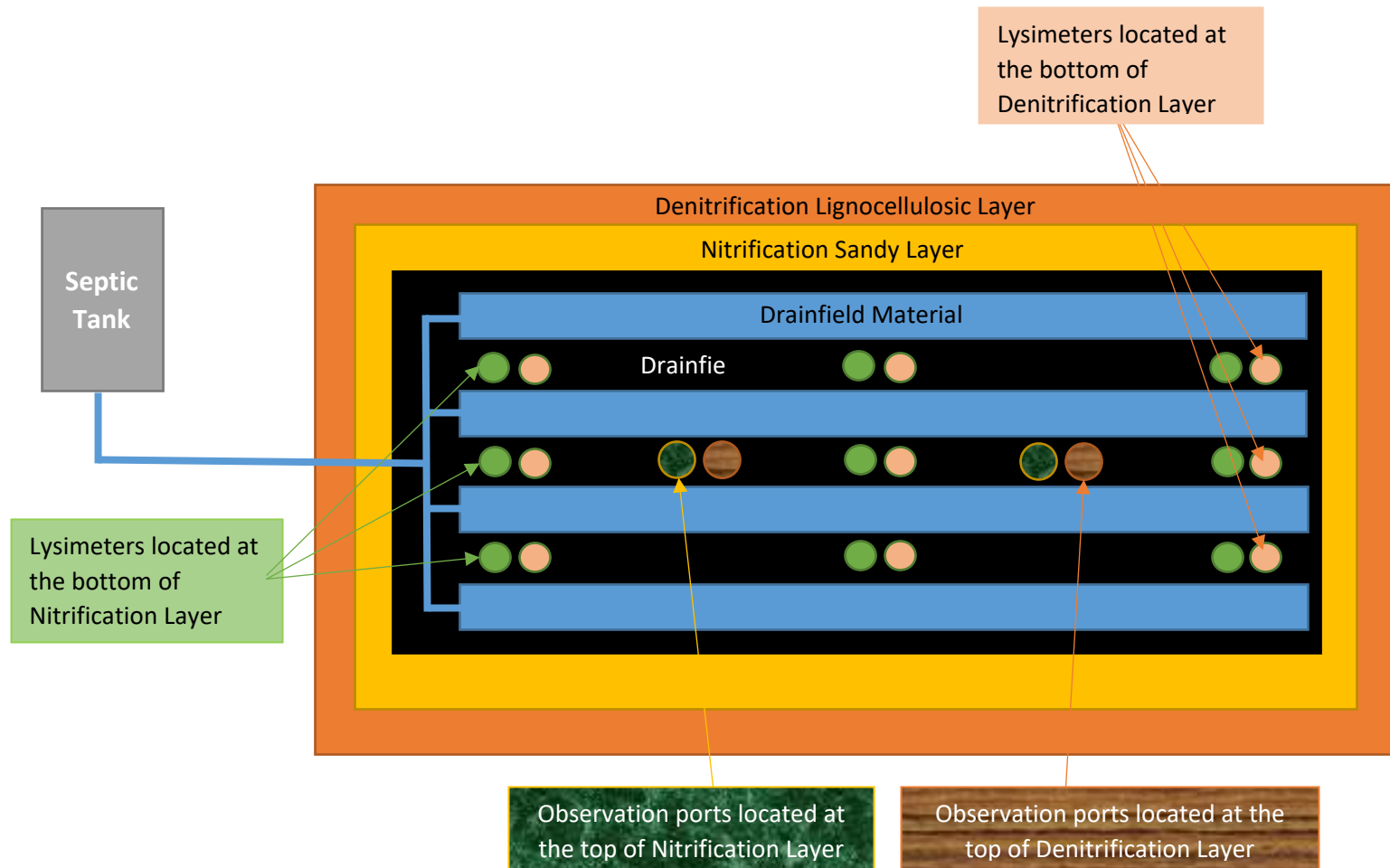


Figure 4. Plan view of Location of Lysimeters and Observation Ports in the In-ground Nitrogen-Reducing Biofilter (INRB)

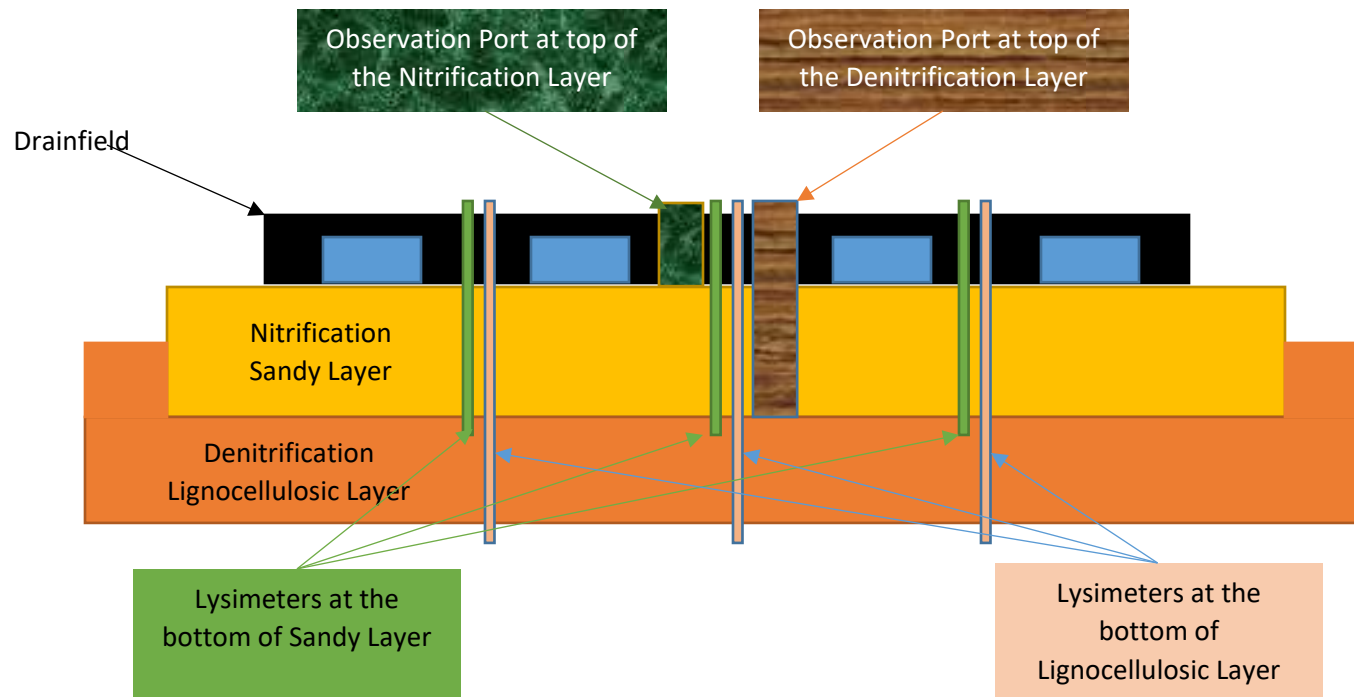


Figure 5. Cross-Section View of Location of Lysimeters and Observation Ports in the In-ground Nitrogen-Reducing Biofilter

this project to ensure that the nitrification taking place in Stage 1 sandy media is not limited by the level of alkalinity. Chloride concentration will be measured to evaluate possible dilution/concentration effect of treated wastewater.

In addition to water quality sample collection, field parameters including dissolved oxygen concentration, conductivity, pH, and oxidation-reduction potential (ORP) will also be measured whenever samples are collected to help understand the function of installed INRBs.

To evaluate possible subsidence as an indicator of the disappearance of lignocellulosic material of the INRB systems to be monitored by this project, elevations of different parts of these systems will be measured whenever sample collection will be conducted. Elevation measurements will include the surface elevation above the drainfield, elevation of the absorption surface, and elevation of the top of the lignocellulosic layer. To measure the elevation of the absorption surface and the top surface of the lignocellulosic layer, observation ports will be installed to the absorption surface and to the top of the lignocellulosic layer (**Figure 5**). Elevations measured from these system locations will provide information regarding the compaction/decomposition of system media through time.

Site specific hydrologic and operating conditions of selected INRBs will be documented, which include household water use, and local monthly rainfall and evapotranspiration. In addition, energy consumption (if any INRB has powered components) and maintenance efforts and cost will be documented to evaluate the cost-effectiveness of the INRBs being monitored. Parallel and subsequent to the monitoring, we will report interim results, analyze data and prepare a final report to the funding agency. The proposed effectiveness evaluation methodology is outlined in the following sections. If, based on the results from this project, the 65% minimum target cannot be achieved, recommendations will be provided either on how to improve the treatment technology or other more reliable nitrogen-reducing technologies will be recommended, which will help county and municipalities achieve nitrogen load reduction goals specified in spring BMAPs.

Each selected INRB system will be monitored on quarterly for six consecutive quarters (18 months). The project is expected to last from January 1, 2020 through June 30, 2021.

Water quality samples collected during this project will be shipped to and analyzed by Advanced Environmental Laboratories, Inc. or another selected environmental laboratory certified through the National Environmental Laboratory Accreditation Program (NELAP) by FDOH. All sample collections and field quality assurance and quality control will follow procedures described in the Task One section above.

Data analysis methods will follow those employed for task one. The major goal of the proposed project is to evaluate whether INRB systems will be able to achieve at least 65% nitrogen-removal effectiveness.

Throughout the study, the results and observations will be reported to the funding agency at a frequency required by the funding agency. Updates on the progress of the study will also be shared with DOH's research review and advisory committee, county health departments and system owners involved.

References:

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